Long, associative, telechelic poly(acrylamide) under shear and elongational flow

Caltech

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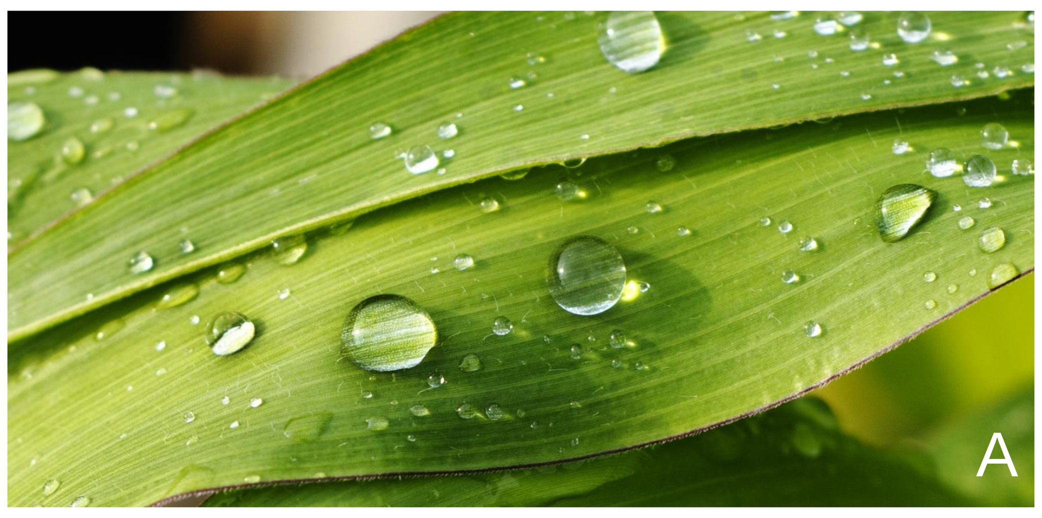
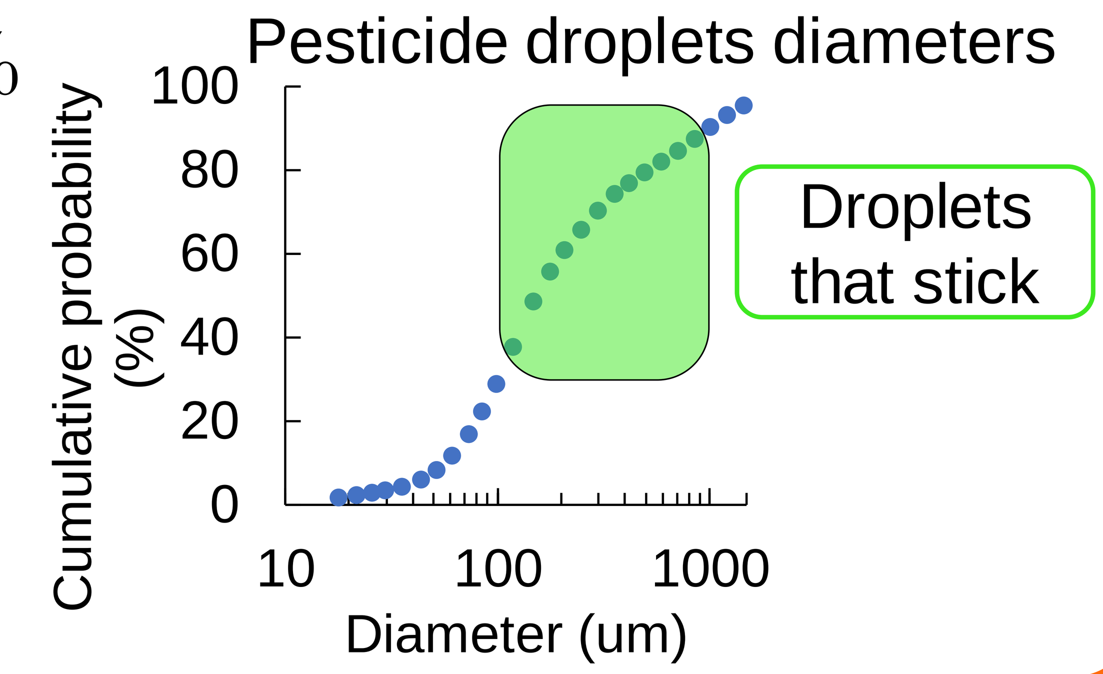


Exacerbated by plants with hydrophobic surfaces such as corn

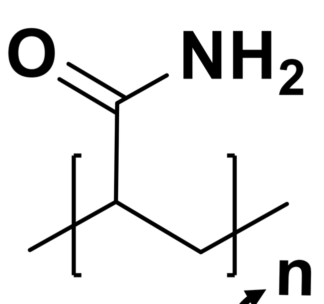
Pesticide off target: currently 50 to 80%

<u>Droplets rarely stick to their target:</u>

- Droplets too small: drift away
- Droplets too large: bounce and shatter

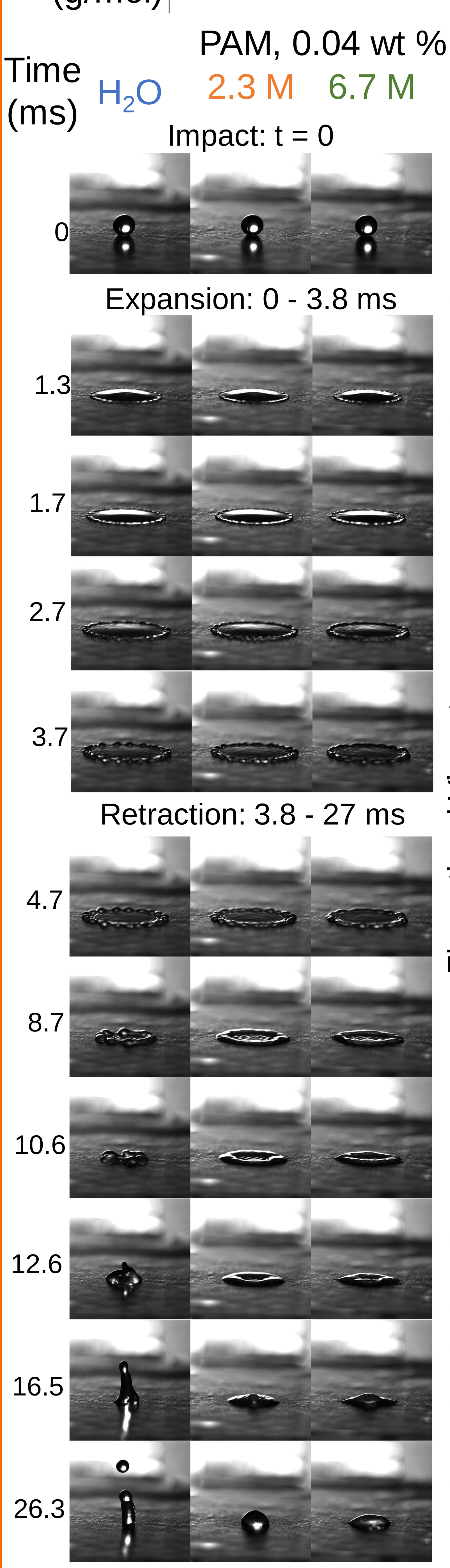


Tailoring droplet impact behavior through extensional viscosity

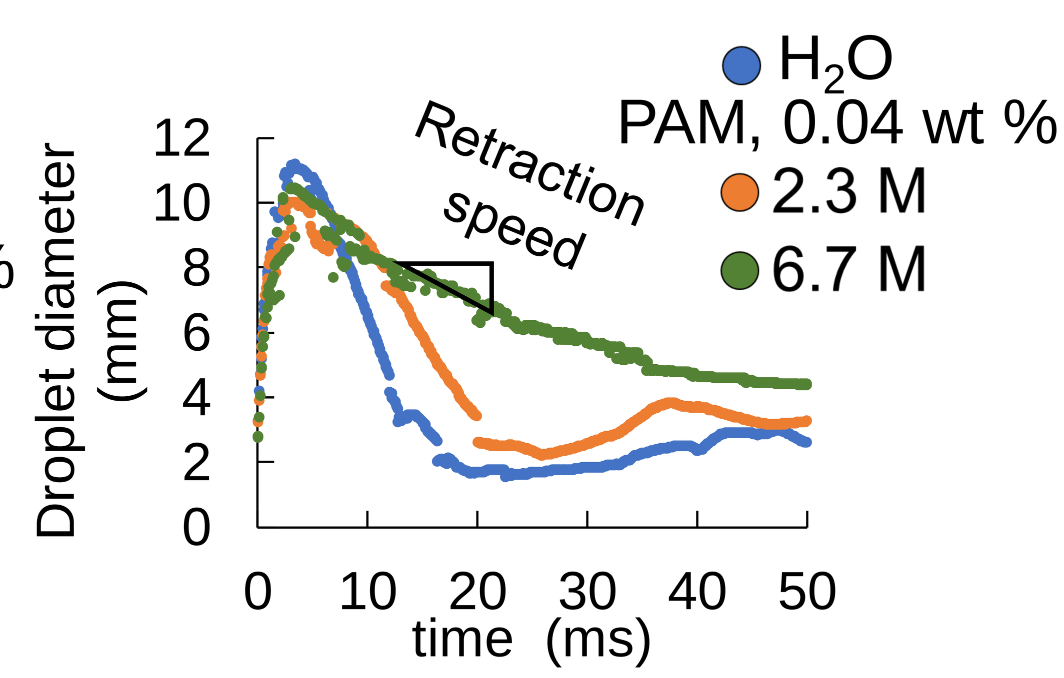


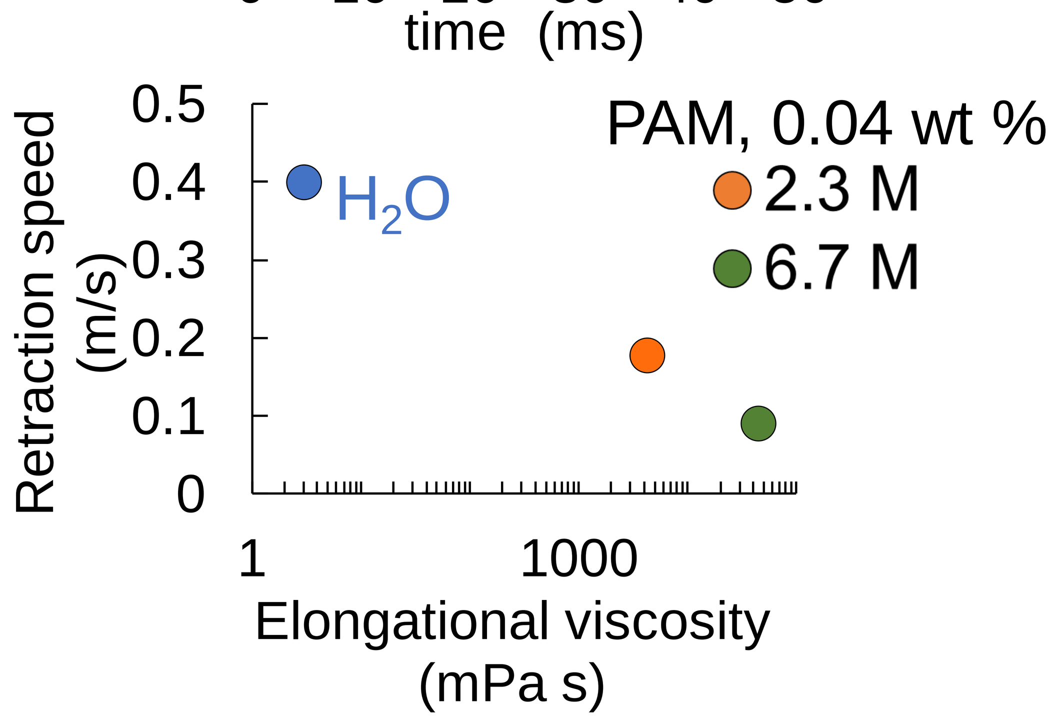
Poly(acrylamide) (PAM)

n	33,000	94,300
M_W (g/mol)	2.3 M	6.7 M

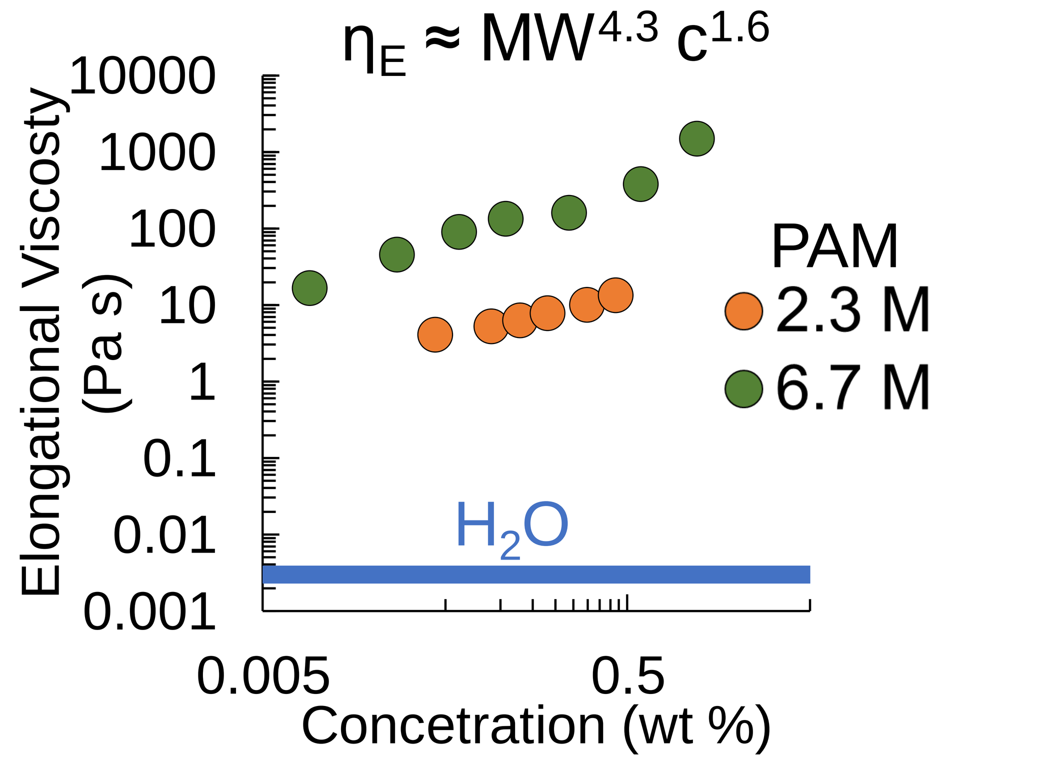


- Retraction is much slower with polymer chains present
- Polymers 2.3 Mg/mol and longer eliminate droplet rebound

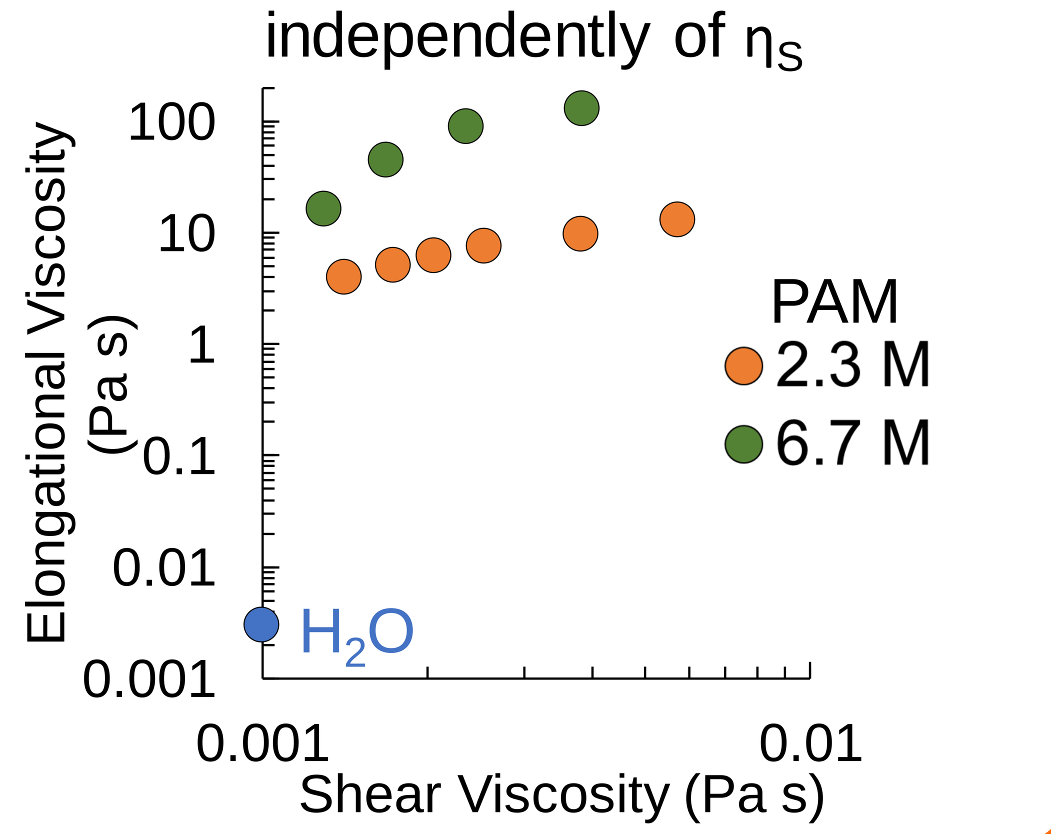




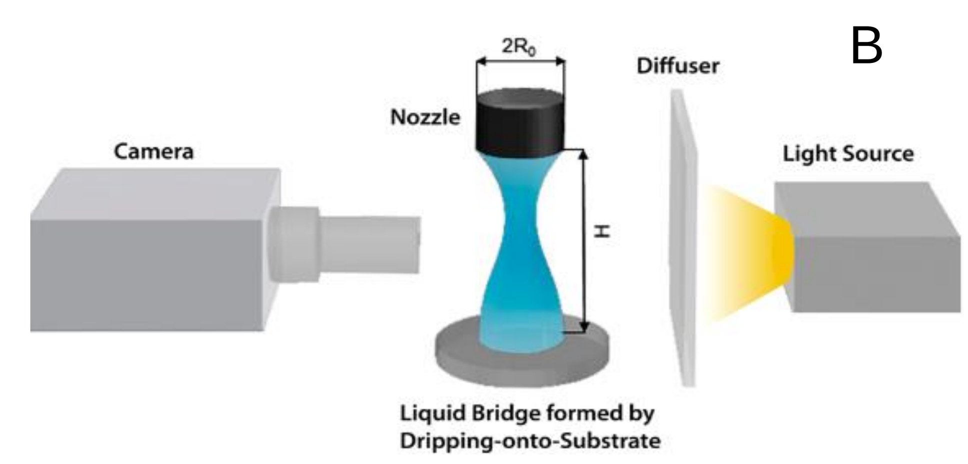
$\eta_E \approx MW^{4.3}\ c^{1.6}$

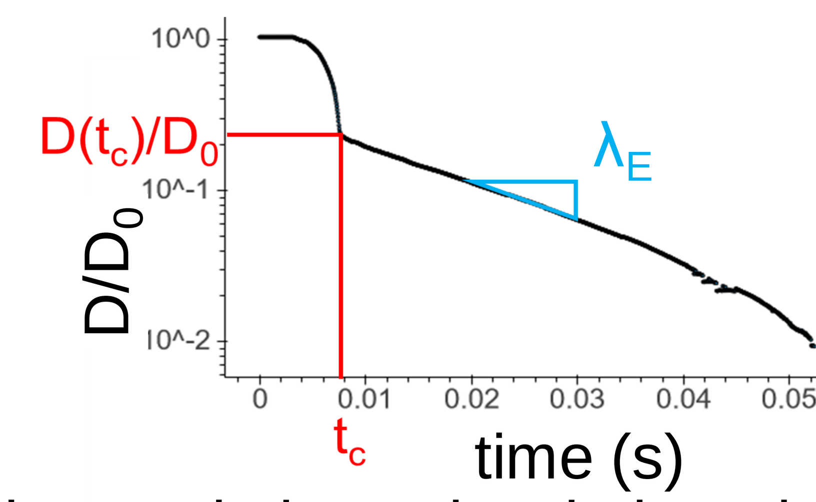


Increasing MW of PAM increases η_E independently of η_S



Dripping onto substrate extensional rheology



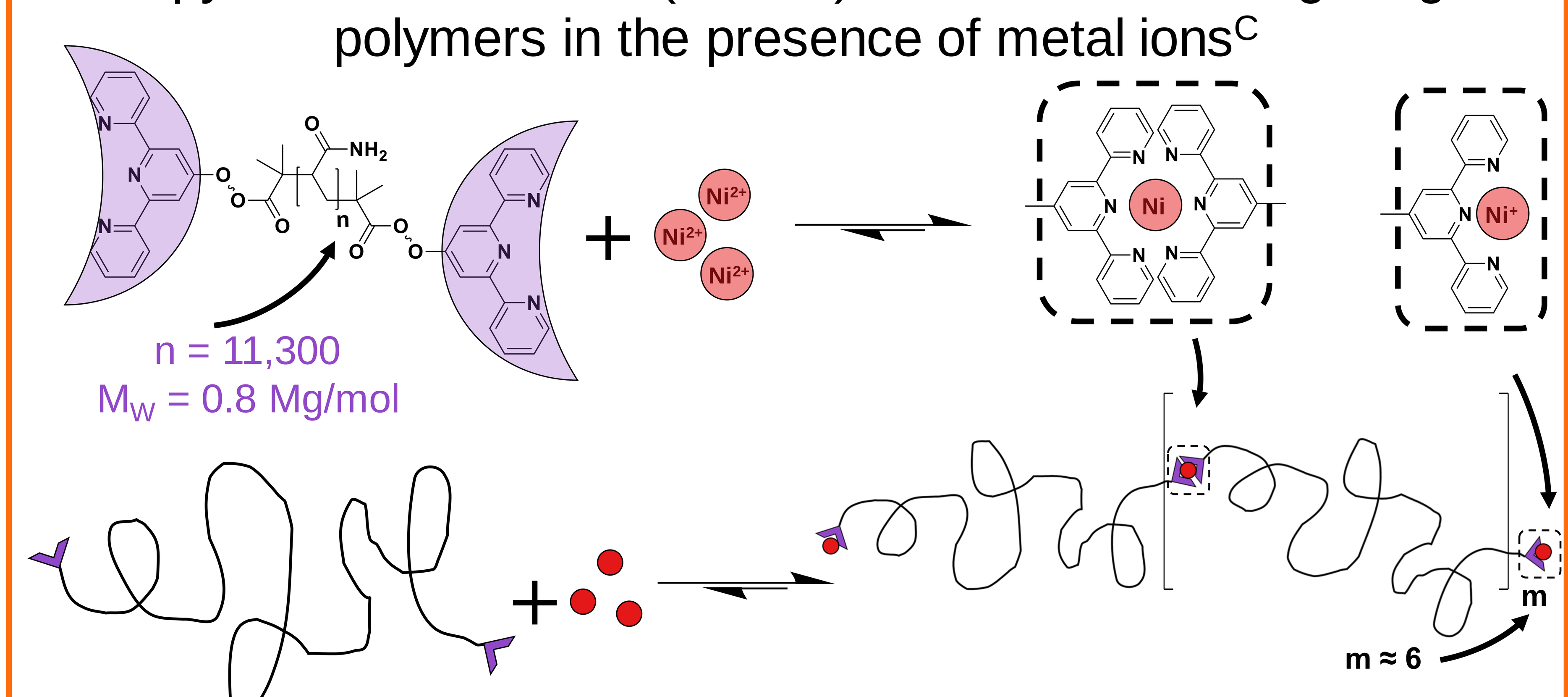


Calculate elongational relaxation time and elongational viscosity from the elastocapillary regime ($t > t_c$)

$$\frac{D(t)}{D0} \cong \frac{D(tc)}{D_0}\exp\left(-\frac{(t-t_c)}{3\lambda_E}\right) \qquad \eta_E = \frac{3\sigma\lambda_E}{D(t_c) * e^{-\frac{(t-t_c)}{3\lambda_E}}}$$

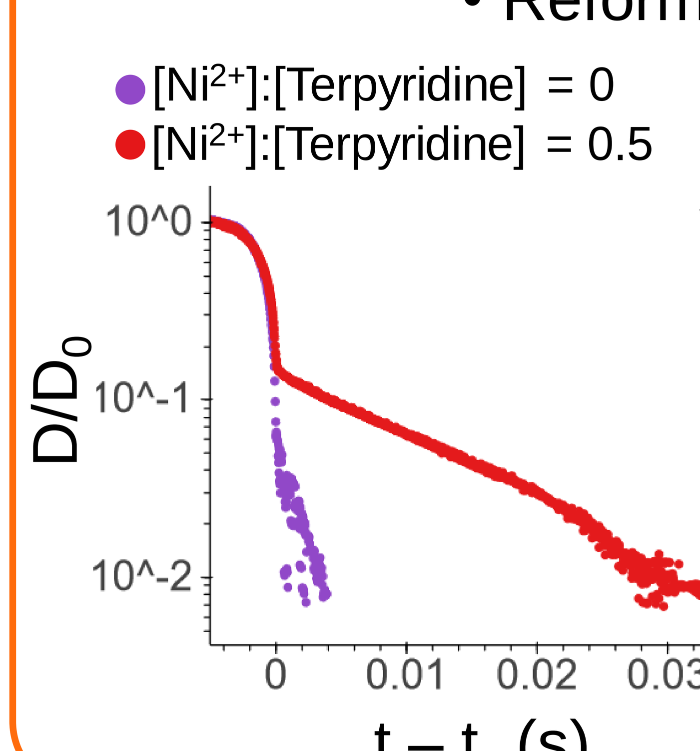
Poly(acrylamide) as an agricultural additive

- PAM is water soluble, biodegradable, and approved for agricultural use
- Terpyridine-ended PAM (T-PAM) associates into long mega-polymers in the presence of metal ions[C]



<u>0.8 Mg/mol T-PAM, 0.1 wt %</u>

- Behaves as 6 Mg/mol covalent PAM with addition of Ni^{2+} in a 1:2 ratio with terpyridine
- Survives 20+ pumping cycles without degradation
- Reforms associations afterwards



Polymer weight %	Ni^{2+}: Terpyridine ratio	λ_E (ms)	η_E (Pa s)	Effective MW (Mg/mol)
1.0	0	0.6	14	0.8
	0.5	76.3	1000	**7.1**
0.1	0	0.2	3	0.8
	0.5	4.5	30	**5.5**

Affiliations, References, and Acknowledgements

A. Josh Stir, Flickr.com
B. Dinic, J. et. al. (2015). *ACS Macro Letters*, *4*(7), 804-808.
C. Lewis, R. W. et. al. (2019). *Chemical Science*, *10*(24), 6174-6183.

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